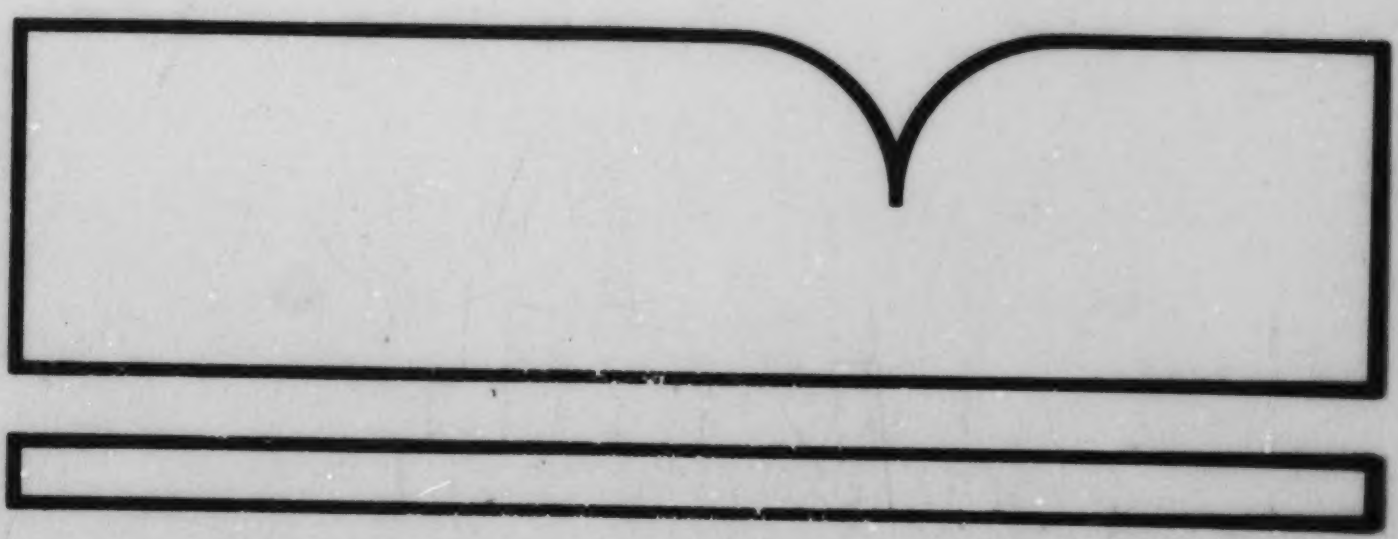
PB84-190875

Computer Model Technology Transfer in the United States

(U.S.) Environmental Research Lab., Athens, GA

May 84



U.S. Department of Commerce
National Technical Information Service
NTIS

PB84-190875

EPA-600/D-84-113
May 1984

COMPUTER MODEL TECHNOLOGY TRANSFER IN THE UNITED STATES

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TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/D-84-113	2.
3. RECIPIENT'S ACCESSION NO. PB84 190875	
4. TITLE AND SUBTITLE: Computer Model Technology Transfer in the United States	5. REPORT DATE: May 1984
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S): Thomas O. Barnwell, Jr.,* and Harry C. Torno**	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS: *U.S. Environmental Protection Agency, Athens GA; **U.S. Environmental Protection Agency, Washington DC	10. PROGRAM ELEMENT NO. AARB1A
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS: U.S. Environmental Protection Agency--Athens GA; Office of Research and Development; Environmental Research Laboratory; Athens GA 30613	13. TYPE OF REPORT AND PERIOD COVERED: Published paper
	14. SPONSORING AGENCY CODE: EPA/600/01
15. SUPPLEMENTARY NOTES	

16. ABSTRACT

Computer-based mathematical models for urban water resources planning, management and design are widely used by engineers and planners in both the public and private sectors. In the United States, the majority of the users are in the private (consulting) sector, yet most of the major model development is done by, or under the sponsorship of, a number of Federal agencies. The Federal government, however, has no effective, centralized system to catalog, maintain, distribute or support these models, and it is frequently difficult for even experienced users to determine what is available, much less make informed judgements about suitability, either from a technical or administrative (cost, availability of documentation, training, user assistance, etc.) standpoint. This paper briefly describes how various Federal and non-Federal agencies address this problem, including the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, the U.S. Geological Survey, the U.S. Department of Agriculture, the National Weather Service and several commercial vendors. Emphasis is on describing how these groups function, and references are provided.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT: RELEASE TO PUBLIC	19. SECURITY CLASS *(This Report)*: UNCLASSIFIED	21. NO. OF PAGES: 12
	20. SECURITY CLASS *(This page)*: UNCLASSIFIED	22. PRICE

EPA Form 2220-1 (9-73)

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ABSTRACT

Computer-based mathematical models for urban water resources planning, management and design are widely used by engineers and planners in both the public and private sectors. In the United States, the majority of users are in the private (consulting) sector, yet most of the major model development is done by, or under the sponsorship of, a number of Federal agencies. The Federal government, however, has no effective, centralized system to catalog, maintain, distribute or support these models, and it is frequently difficult for even experienced users to determine what is available, much less make informed judgements about suitability, either from a technical or administrative (cost, availability of documentation, training or user assistance, etc.) standpoint. This paper briefly describes how various Federal and non-Federal Agencies address this problem, including the U. S. Environmental Protection Agency, the U. S. Army Corps of Engineers, the U. S. Geological Survey, the U. S. Department of Agriculture, the National Weather Service and several commercial vendors. Emphasis is on describing how these groups function, and references are provided.

Keywords: Hydraulic modeling, hydrologic modeling, mathematical modeling, urban water resources, technology transfer.

INTRODUCTION

Computer-based mathematical models for urban water resources planning, management and design are widely used by engineers and planners in both the public and private sectors. In the United States, the majority of users are in the private (consulting) sector, yet most of the major model development is done by, or under the sponsorship of, a number of Federal agencies. The Federal government, however, has no effective, centralized system to catalog, maintain, distribute or support these models, and virtually all Federal modeling activities are currently managed on an agency-by-agency basis (Office of Technology Assessment, 1982). These agencies, moreover, have widely varying policies about model dissemination and support. There are, furthermore, no private organizations performing this function. The result is that model users have great difficulty determining what is available, and even more difficulty making informed judgements about model suitability, either from a technical (applicability to the problem under study) or administrative (cost, availability of documentation, training or user assistance, etc.) standpoint. This paper will briefly describe how the principal Federal agencies involved in urban water resources modeling handle technology transfer, and will also cite some non-Federal activities.

URBAN WATER RESOURCES MODEL TECHNOLOGY TRANSFER

An excellent summary of urban drainage and receiving water models has been prepared by Huber and Heaney (1982) and by Hinson and Basta (1982), cataloging the most significant models in use at the time and indicating sources for each. Careful perusal will clearly show that most of the models were developed or supported by the Federal government.

Federal Agency Activities

The agencies described were chosen because they were the most significant in the urban water area and because they represent a spectrum of Federal activities. The list is not, however, exhaustive.

U. S. Environmental Protection Agency (EPA)

The principal agent for surface runoff and water quality model technology transfer in EPA is the Center for Water Quality Modeling at the Environmental Research Laboratory in Athens, Georgia. The Center provides a central file and distribution point for selected models and their documentation and sponsors workshops and seminars, open to the public, that provide both generalized training and specific instruction in the application of individual models.

The modeling packages currently available through the Center were selected from many candidate models by the Center staff. Selection criteria included model utility and effectiveness, availability of adequate documentation, degree of acceptance and application, and the Center staff's experience with the software. A wide range of analysis tools is provided, ranging from simple desk-top techniques suitable for screening analysis, through computerized steady-state models, to sophisticated, state-of-the-art, continuous simulation

models. Modeling packages currently supported by the Center are described in more detail in a separate paper in this Conference by Barnwell (1984).

The Center provides, in response to requests for software, copies of model documentation and a magnetic tape of the computer code, to be copied by the user and returned. The Center functions as a clearing house for correcting coding errors or other problems, issuing new software releases periodically to document code updates and corrections. The Center also sponsors the Storm Water and Water Quality Model Users Group (formerly SWMM Users Group), consisting of a large number of model users and developers in international, Federal, regional, State, and local environmental management agencies, private industry, and academia. The Users Group meets semi-annually to discuss applications and results of model use. Discussions are not confined to EPA-sponsored models. This forum enables the timely exchange of information on model refinements, code changes, and model adaptations, as well as identification of problem areas and model use limitations. The meetings alternate between the U. S. and Canada. Proceedings of U. S. meetings are published by EPA and furnished to Users Group members free of charge. Proceedings of Canadian meetings are published on an ad-hoc basis by the meeting host and there is usually a nominal charge for them.

The Center periodically distributes, free of charge, a newsletter to Users Group members. The newsletter provides helpful hints to model users and communicates information on scheduled workshops, model improvements and developments, the availability of technical documents, and planned meetings and conferences. Persons interested in the Center, or in more information on supported models, can write to Thomas O. Barnwell, Jr., Center for Water Quality Modeling, U.S. EPA, Athens, Georgia 30613.

EPA also sponsors the EPA Information Clearinghouse, which maintains an Environmental Data Base and Model Directory (Weiss, 1983). The Agency annually conducts a survey to update the descriptions of each environmental measurement data base and environmental model operated or funded by EPA. The information contained in the Directory encompasses all media (air, water, etc.) and programs (Radiation, Pesticides, Municipal Waste, etc.) for which the Agency has responsibility. A limited number of copies of the 1625-page Directory are available from the author.

U.S. Army Corps of Engineers

The Hydrologic Engineering Center (HEC) is probably the best organized and most comprehensive modeling and technology transfer group in the U. S. Government. Eichert (1984) has described their activities and programs. Organized primarily to assist Corps of Engineers professionals in applying state-of-the-art technology, HEC also provides programs and documentation to the general public.

HEC supports a wide variety of programs, including some that were developed by other Federal agencies or their consultants, all of which are documented with a users manual. HEC also has staff members assigned to each major program to provide advice and assistance

to users. Training courses are provided, but attendance is generally limited to Corps of Engineers employees. Many course lectures have been videotaped, however, and are available to the general public, as are workshop problems and training course manuals. Catalogs are available from HEC describing available material.

HEC's software development goal is to provide efficient tools useful to large numbers of people. New programs are written using top-down, modular, programming and ANSI Standard FORTRAN 77 (some existing programs use FORTRAN IV and will probably continue to do so) and are designed to be easily understood and compatible with a variety of computer systems. HEC programs are available to the general public, either from commercial "service bureau" vendors or directly from HEC. HEC also provides error correction and updating information to individuals or organizations using their programs. Further information may be obtained from the Director, Hydrologic Engineering Center, 609 Second Street, Suite D, Davis, California 95616.

The Waterways Experiment Station (WES) is also an active developer of computer models. The Environmental Laboratory at WES is conducting a major model development and technology transfer program for the analysis of water quality problems in reservoirs and waterways. EWQOS (Environmental and Water Quality Operational Studies) has produced a state-of-the-art, one-dimensional reservoir water quality model and a computationally efficient, two-dimensional reservoir hydrodynamics model. A comprehensive evaluation of the applicability of steady-state, nutrient balance/trophic status models for reservoirs is also underway. EWQOS is committed to a technology transfer program within the Corps of Engineers and has conducted training courses on CE-QUAL-R1. Non-Corps personnel can attend these courses by special arrangement. Information on EWQOS is available through a bulletin published on an irregular basis by WES. Further information may be obtained from the Environmental Laboratory (Attn: J. L. Mahloch), U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Mississippi 39180.

U. S. Geological Survey (USGS)

The Water Resources Division of the USGS collects long-term multipurpose data on surface and ground water flow, water quality and water use, performs studies of the physical, chemical, and biological characteristics of water, and conducts a wide variety of other water-related investigations. Water resource models are used in all phases of their work. Urban water resource modeling activities are concentrated in the Surface Water Branch and are conducted primarily under their Federal-State cooperative program and in conjunction with EPA's Nationwide Urban Runoff Program (NURP). Most of the modeling done is related to specific projects, so there has been less emphasis on the development of generalized programs. While the USGS has no formal model technology transfer mechanism serving the general public at this time, informal transfer does take place, and the USGS will furnish programs and documentation to interested users. The USGS also operates the National Water Data Exchange (NAWDEX), which provides access to a nationwide water-related data base, and provides assistance to users of water data in identifying,

locating, and acquiring needed data. NAWDEX data can be used by private consultants on a fee basis. It is possible to distribute models through the NAWDEX system as well. While this is not generally done at the present time, it may be done in the future (Cobb, 1982). The USGS also provides training in a wide range of water-related topics, including modeling, at their National Training Center in Lakewood, Colorado. Attendance, however is generally limited to personnel from the Federal government, State agencies, and international organizations. Further information about USGS activities can be obtained from the Chief Hydrologist, U. S. Geological Survey, 410 National Center, Reston, Virginia 22092.

National Weather Service (NWS)

The National Weather Service, a part of the National Oceanographic and Atmospheric Administration, is responsible for issuing weather and river (flood) forecasts and warnings. Mathematical models are vitally important in the development of hydrologic forecasts, and the NWS has developed a system of interrelated models and predictive techniques known as the National Weather Service River Forecast System. At least two models in the system, DMBREAK and DWOPER, are widely used in the public and private sector for such purposes as dam failure analysis and flood-wave hazard analysis. (These models are, for instance, also part of the HEC library, and are documented and distributed by them.) The NWS is the U. S. agent for the World Meteorological Organization's (WMO) Hydrologic Operational Multipurpose Subprogramme (HOMS), which is a framework for the organized transfer of hydrological technology, including instrument catalogs, software packages, and general guidance and detailed manuals on the use of this technology under differing conditions. Components already available to the World Meteorological Organization are integrated with others contributed by member countries (Zevin, 1983).

In addition to the HOMS information exchange, there is informal transfer of such models as DMBREAK and DWOPER by the NWS, and individuals or organizations from either the public or private sectors may obtain models and documentation. Model recipients also routinely receive updates and corrections to these models. Training is limited, but NWS staff have conducted courses in model use at universities that are open to the general public. Further information may be obtained from the Office of Hydrology, National Weather Service, 8060 13th Street, Silver Spring, Maryland 20910.

Tennessee Valley Authority (TVA)

The Tennessee Valley Authority's Water Systems Development Branch provides research and development services within TVA and to outside agencies and institutions. Staff expertise includes fluid dynamics, heat transfer, geohydrology, and water resources planning and management. A variety of hydrodynamic and water quality models are used by TVA, including computer models developed in-house and by others. TVA does not have a formal technology transfer program, but computer models are available and are described in TVA (1981).

U. S. Department of Agriculture (USDA)

The USDA has several agencies that develop and apply water resources computer models, described in Office of Technology Assessment (1982), including the Economics Research Service (ERS), the Forest Service, the Agricultural Research Service, and the Soil Conservation Service (SCS). For the most part, USDA activities are agriculture-related, but it has certain responsibilities in urban water resources management. For example, ERS has helped to formulate policy models to evaluate alternatives for water quality management, and the SCS has a specific mission in rural community development and small watershed flood control projects. Several SCS hydrologic methods are widely used in urban drainage design in the U.S. and Canada.

The ERS (formerly the Economics, Statistics and Cooperative Service) prepared the Land and Water Resources and Economics Modeling System (LAWREMS), a directory of models and data within USDA agencies (Dyke and Hagen, 1979). The directory contains about 300 entries in three areas: data sets (125), programs and models (160) and information systems (15). It is designed to direct users to the individuals or organizations that have developed models and data bases, but is not routinely updated. A limited number of copies are available from the authors.

The SCS is the most active USDA agency in the urban water resources area. Some widely used SCS analytical methods include TR-20 (SCS, 1983) and TR-55 (SCS, 1975). These and other methods are abstracted in the Hydrologic Operational Multipurpose Subprogramme (HOMS) of the WMO. The SCS conducts training for USDA staff only, but the methods are taught in several universities, and a textbook describing them is available (McCuen, 1982).

U.S. Department of the Interior (USDI)

The Cooperative Instream Flow Group of the Fish and Wildlife Service was created to provide a source of expertise and analysis tools for analyzing instream flow needs, directed primarily at the arid regions in the Western U.S. (Office of Technology Assessment, 1982). Consisting of personnel from the physical, biological, and social sciences, the group has concentrated on developing a data base and providing technical assistance on various aspects of stream flow protection. One of its major efforts has been to develop a comprehensive methodology to analyze the effects of incremental changes in flow on instream uses and to analyze tradeoffs between instream and offstream uses in regional assessments (Bovee, 1982). The group provides two types of assistance to users of its computer-based models in State and Federal government. It offers training opportunities in such diverse subjects as Western water law, field investigation techniques, and computer analysis. It also provides technical assistance to both analysts and administrators involved in instream flow assessments.

National Technical Information Service (NTIS)

A part of the Department of Commerce, NTIS is the primary source for public sale of Government-sponsored research, development and engi-

neering reports, and collects and sells data files and computer programs from Federal sources. It does not, however, provide user-oriented services such as model updating or correction, user assistance, or training. These must be obtained, if possible, from the original source. For this reason, and because water resource models are only a minute fraction of the entries in the NTIS system, model users usually prefer to go directly to the source.

Commercial Technology Transfer

There is no comprehensive, general commercial source for urban water resources models, and prospective users are faced with a bewildering array of choices. The magazine "Civil Engineering," published by the American Society of Civil Engineers, typically has several pages of advertisements for software, including many programs related to urban water resources. Other professional publications list similar offerings. Computer service bureaus frequently offer one or more urban water models in their libraries, available to customers purchasing computer time.

The Society for Computer Applications in Engineering, Planning and Architecture (CEPA), is an independent association of professionals involved with computers and has over 300 member organizations, mostly consulting firms. CEPA provides a means for information exchange and for the exchange and cooperative development of computer programs in engineering, planning, and architecture. Many member organizations are working in the water resources field, although a number of firms in this field are not represented. The CEPA program library contains water-related software developed by CEPA member organizations and by others. Federal agencies are welcomed as CEPA members, but few agencies avail themselves of the opportunity. As a result, few of the most common urban water resources models (which are largely supported by government agencies) appear in the CEPA library. CEPA is also a charter member of the International Federation of Associations of Computer Users in Engineering Architecture and Related Fields (FACE). CEPA, together with the American Society of Civil Engineers and the ICES Users Group, is organizing a National Institute for Computers in Engineering (NICE), which is intended to be a comprehensive source of information or referral on computer use in engineering and related fields. Further information on CEPA, NICE, and FACE may be obtained from the Society for Computer Applications in Engineering, Planning and Architecture, Inc., 358 Hungerford Drive, Rockville, Maryland 20850.

CONCLUSIONS

Recent years have seen dramatic increases in the development and use of computer-based mathematical models for the analysis and solution of urban water resources problems. A lack of effective, national mechanisms for the transfer of this burgeoning technology has hampered its effective use. The Federal government, which has sponsored, directly or indirectly, most of the new models and their applications, is generally unwilling to accept this responsibility and leaves it to individual Agency initiative. Support for model technology transfer is limited in all agencies, and some, in fact, have a policy of discouraging this transfer, apparently because of the

resource costs involved (Office of Technology Assessment, 1982). There is also a perception that such matters are better left to the private sector.

The commercial organizations fare little better. Much of the software offered by "cottage industry" suppliers is of uncertain quality. There seems to be considerable reluctance to enter into a general exchange of software, even in respected users groups such as CEPA. There is the perception (false, in the authors' experience) that a competitive advantage will be lost in such an exchange. Writers of software also show a concern for potential liability resulting from misuse. This concern typically manifests itself in statements like "XYZ Software, Inc. specifically disclaims any implied warranties....or fitness for any particular purpose." From the user's viewpoint, such disclaimers do not foster confidence in commercial software, and there is an emerging concern about who can, and should, serve as an independent reviewer and judge. Perhaps the most valuable function served by users groups is the discussion, both formal and informal, of the useability of available software.

There are, however, promising signs on the horizon. Large-scale user organizations such as NICE, FACE, and HOMS are growing in influence, and may fill some of the gaps. There is increasing interest in the use of mini/micro computers in urban water resources, which can only serve to make models more accessible, and many Federal agencies are adapting models to these small systems. These small computers are becoming more powerful (32-bit micros are already on the market) and less costly by the day and promise to place even large-scale modeling capability in the hands of virtually any user in the not-too-distant future. This, in turn, should encourage the broader "marketing" and review of water resource models by both the public and private sectors and the expansion of user organizations.

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